44th IAVS Symposium: Vegetation and ecosystem functions - Freising-Weihenstephan 2001

Artemisia annua

a successful invading species

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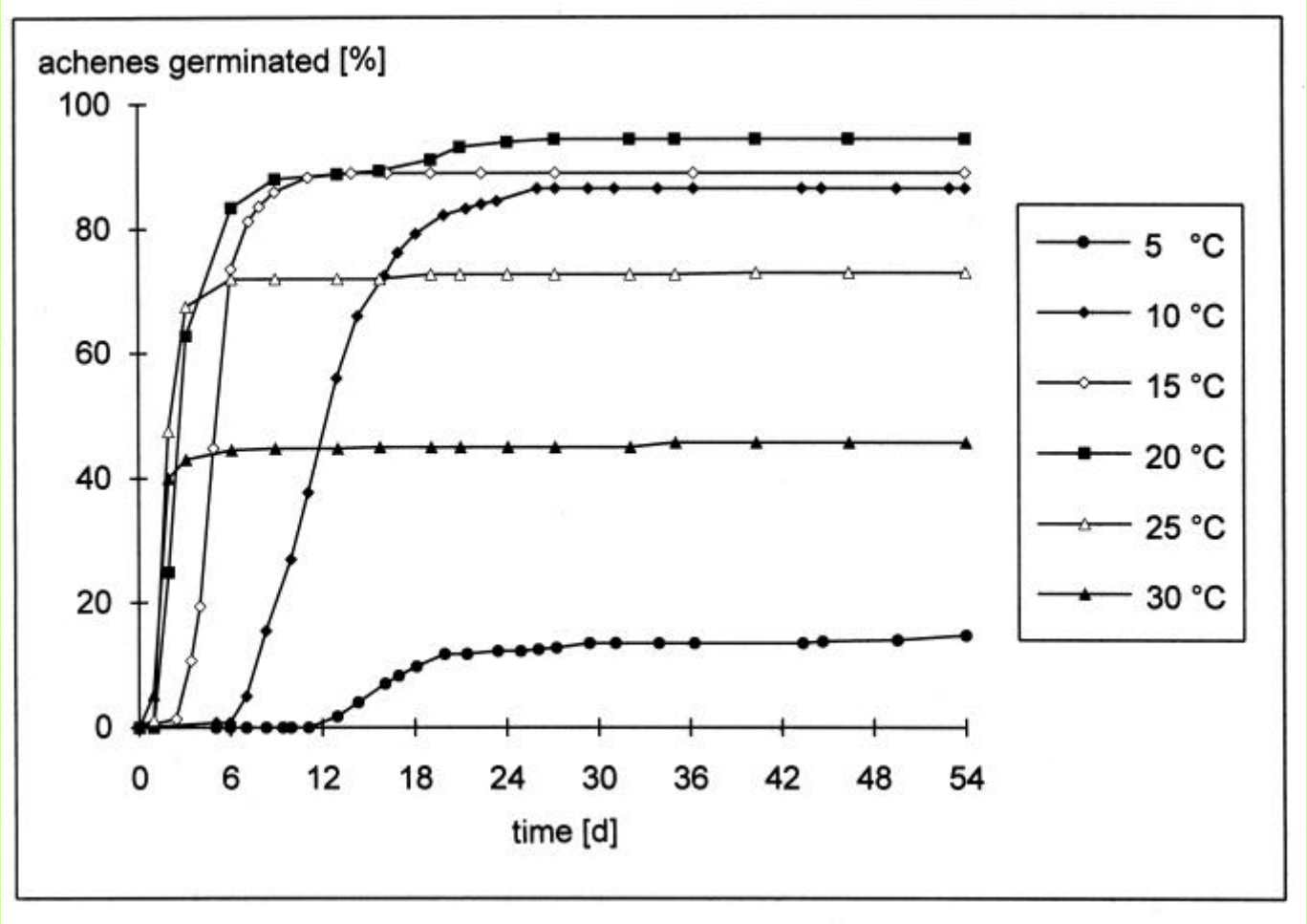
Artemisia annua

According to our experiments the most important reasons in spreading are:

- Artemisia annua produces large quantities of diaspores:
  - average: 120.000 diaspores / individual
  - maximum: 800.000 dispores / individual

- The diaspores germinate over a wide range of temperature [from 5°C to 30°C], preferably between 10°C and 20°C
- Artemisia annua is therefore able to germinate in situ from spring to autumn
- Artemisia annua shows high germinating capacity (95 % ± 3 %) at 20°C
- The germinating usually needs light
- The seedlings reach the surface only, if they are buried less than 2.0 (2.5) cm
- The germination is successful even under water (15%)

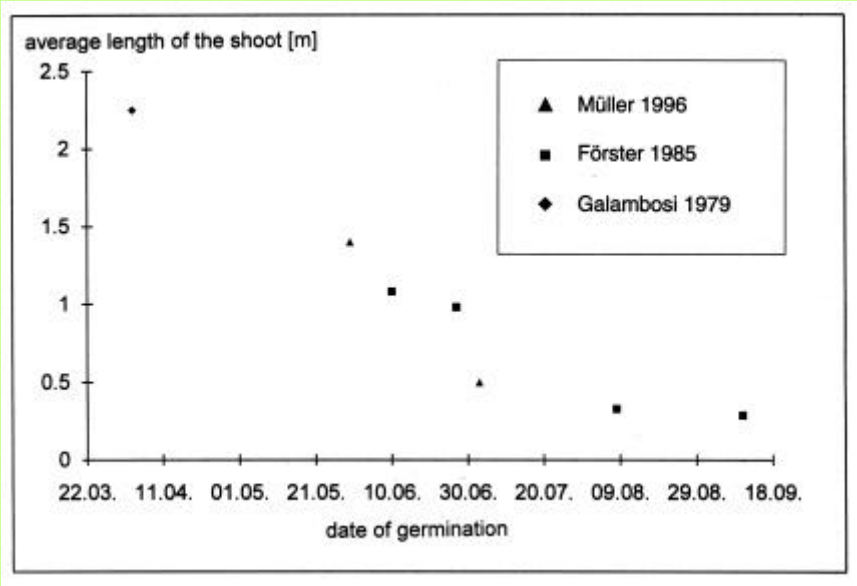
Germinating



The diaspores germinate over a wide range of temperature, preferably between 10°C and 20°C.

Development of Artemisa annua as a function of the date of germination

At the banks of large rivers Artemisia annua is germinating at different times.



Average shoot length vs. date of germination

Development of Artemisia annua as a function of the date of germination

- Early germinated individuals are higher and show more lateral branches.
- The stimulation of flowering is caused by decreasing day length. This supposition of Förster (1985) was proven by us with experiments: The skotophile period is about 9 – 9,5 h, which equals stimulation between 10th and 18th of August in Germany.
- After the stimulation of flowering the vegetative growth changes to reproductive growth.

Development of Artemisia annua as a function of the date of germination

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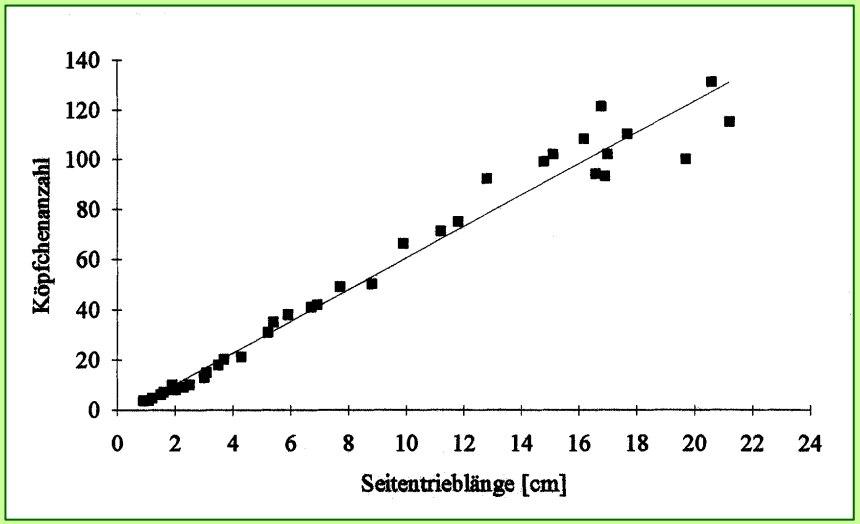
The more time there is for growing of the individuals the more lateral branches are developed. Early germinated individuals therefore have more time for the vegetative growth than those germinated late.

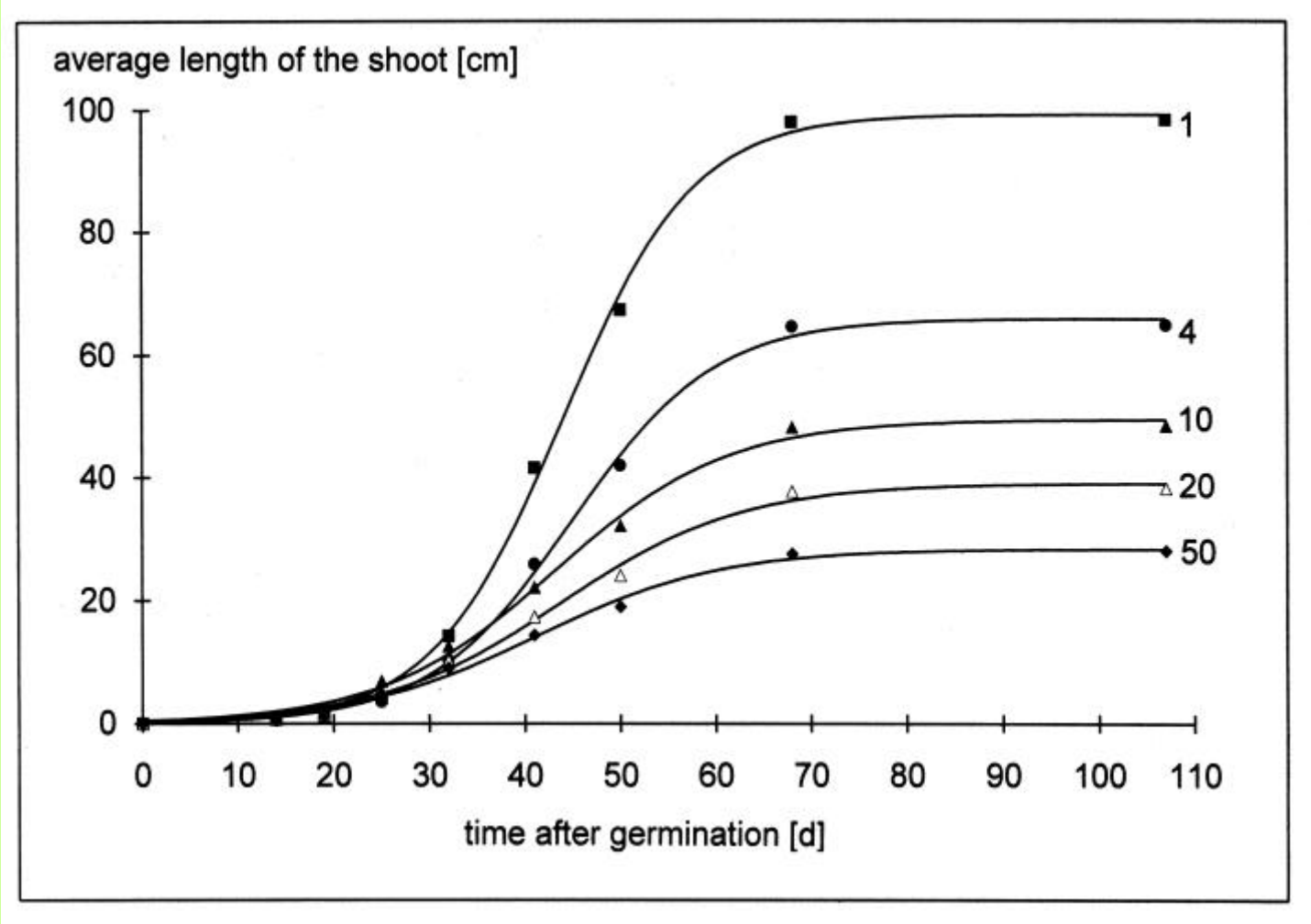
The number of capitula shows a linear correlation with the length of lateral branches:



Infraspecific competition

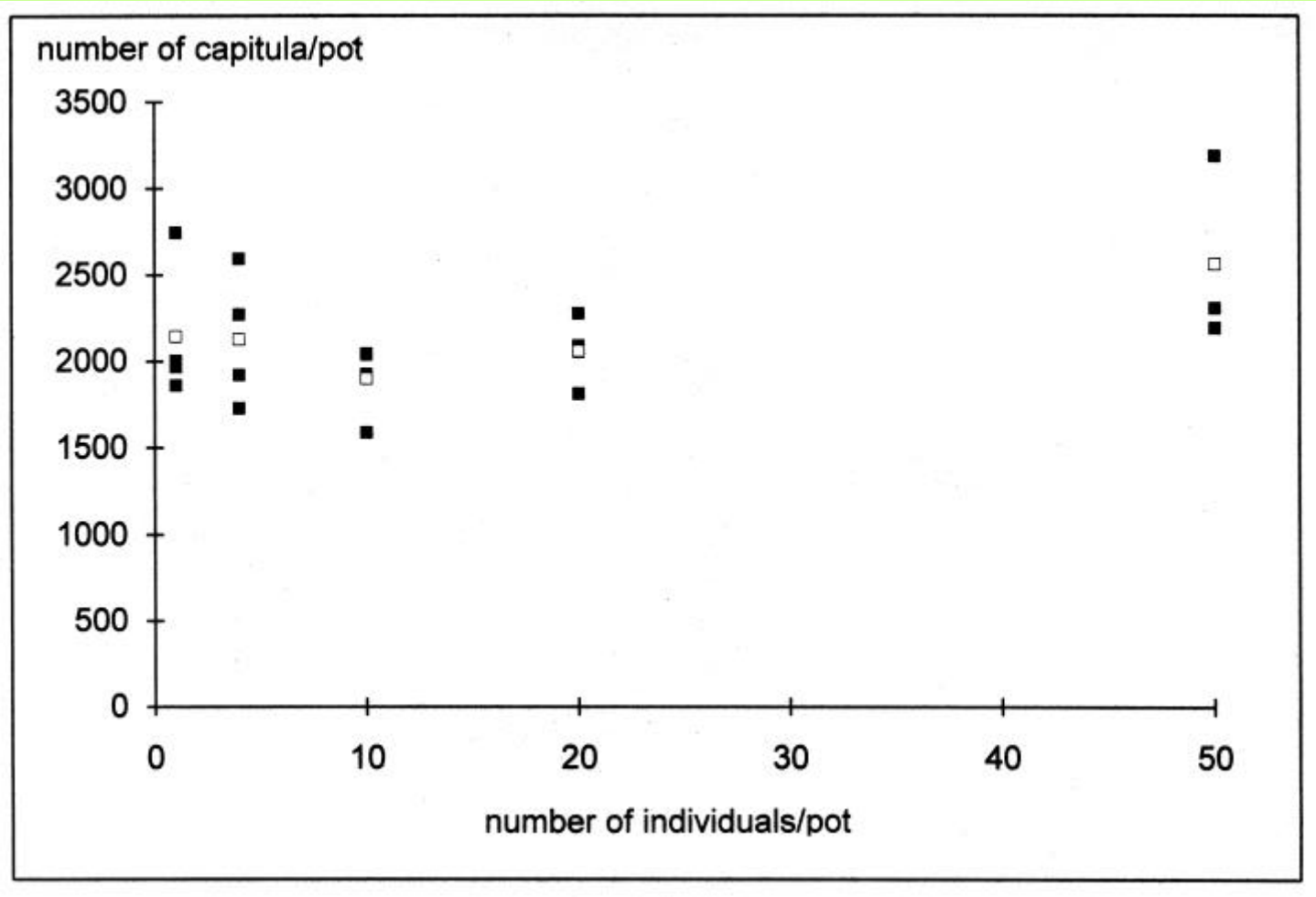
- Increasing plant density leads to smaller plants growing with lower rate
- Even at high density all plants are flowering and fruiting
- The number of capitula per plant is decreasing; the number of capitula per pot however remains constant

Infraspecific competition



1 plant/pot => 50 plants/m²; 50 plants/pot => 2487 plants/m²

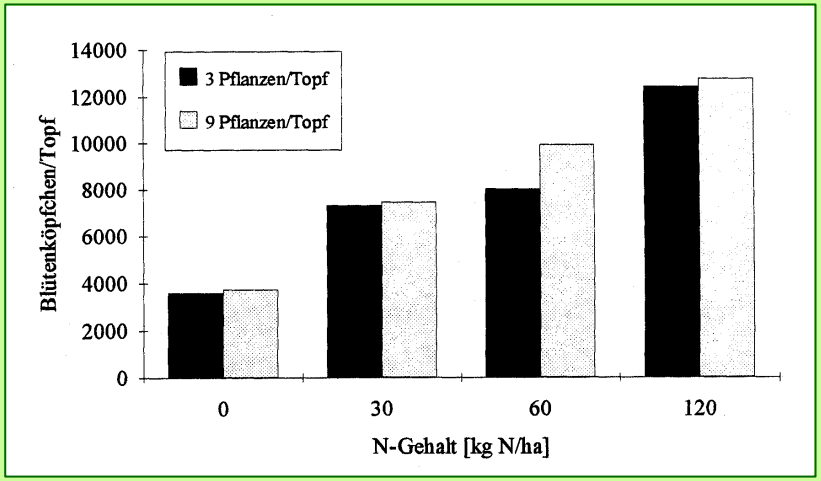
Infraspecific competition

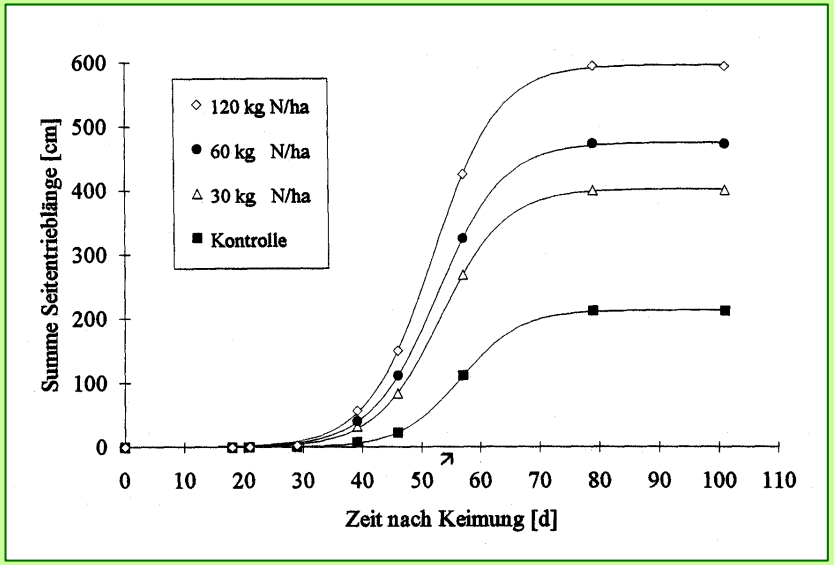


1 plant/pot => 50 plants/m²; 50 plants/pot => 2487 plants/m²

Effects of nitrogen supply

- The demands for nutrient richness of the growing place is low
- Nitrogen fertilizing however leads to enriched production of diaspores:





Increase of number of capitula with nitrogen supply (left); cumulative length of lateral branches vs. time after germination (right)

Habitats of Artemisia annua

- The natural habitats are sandy banks of rivers and lakes as well as wadis in steppes and semi deserts of Asia.

- In China A.a. is occurring in often disturbed habitats like waste land, roadsides, slopes, and river banks.

- Also in the synanthropic area of distribution A.a. prefers regions with summer rain. The successful spreading of Artemisia annua is narrowly linked to unstable habitats where it fits in ruderal plant communities on dry grounds or sandy and gravelly river banks as well.

Phytosociology of Artemisia annua

In Central Europe Artemisia annua fits into some open and short-lived communities:

Bidentetea

Xanthio albini-Chenopodietum rubri Lohm. & Walth. in Lohm. 1950 [D: Elbe]

Portulaca oleracea - Corrigiola litoralis community [D: Elbe]

Artemisia biennis community [D: Elbe]

Polygono lapathifolii-Xanthietum italici Pirola & Rossetti 1974 [I: small rivers]

Phytosociology of Artemisia annua

Stellarietea

Artemisietum annuae Fijalkowski 1967 [= Sisymbrion communities with dominant Artemisia annua]

[PL, SK, CZ (?), D, I, F]

Sisymbrio-Atriplicetum nitentis Oberd. Ex Mahn & Schub. 1962 [D]

Polygono-Poetea

Polygono-Matricarietum discoideae (Siss. 1969) Tx. 1972 [D]

Artemisietea

Artemisia absinthium – Verbascum phlomoides – community [I]

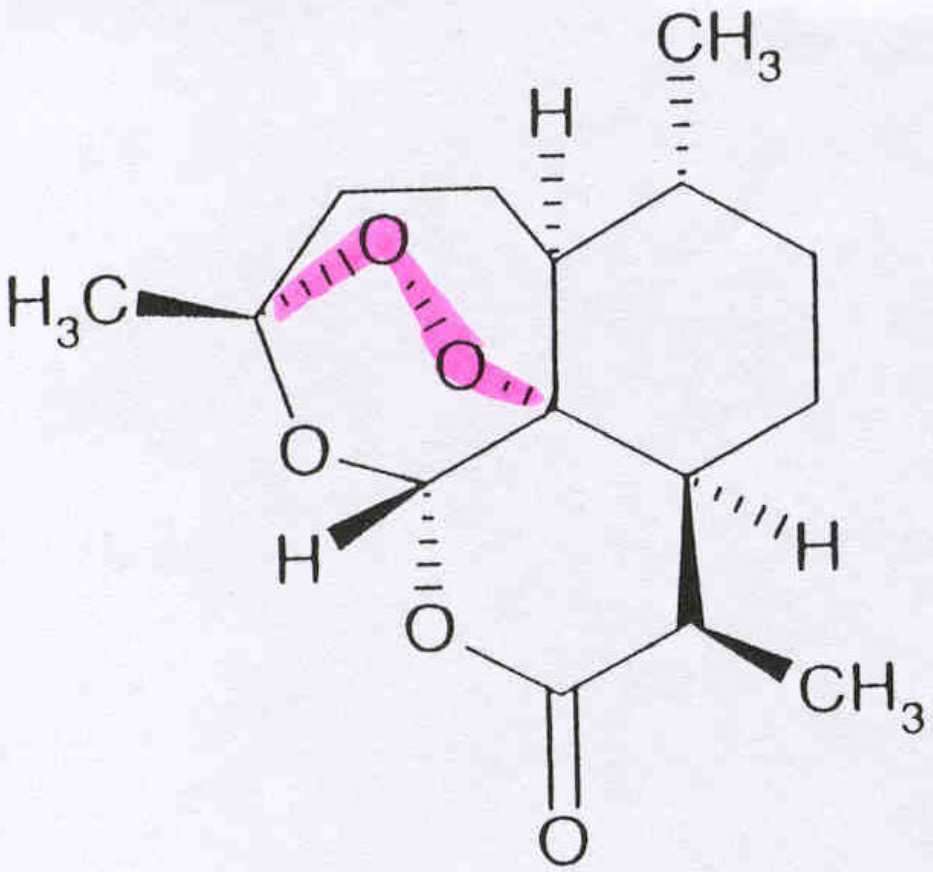
Region	PL	SK	I	I	F	D
Author	Fij.	Jar.	Br.	Br.	Br.	Br.
Number of relevés	5	14	11	7	9	8
Artemisia annua	**100**	**100**	**100**	**100**	**100**	**100**
Species of Sisymbrion/Sisymbrietalia:						
Conyza canadensis	40	14	27	43	100	25
Lactuca serriola	40	57	73	57	56	25
Amaranthus retroflexus	60	71	27	14	.	38
Tripleurospermum inodorum	20	86	.	14	.	38
Bromus sterilis et rigidus	.	.	55	29	22	.
Hordeum murinum	.	.	82	.	33	.
Lepidium ruderale	20	29	.	.	.	50
Species of Stellarietea:						
Chenopodium album	60	64	91	100	11	63
Fallopia convolvulus	20	14	18	.	.	25
Atriplex patula	40	36	9	29	.	.
Solanum nigrum	.	21	36	14	11	.
Sonchus oleraceus	.	21	18	.	56	50
Stellaria media	.	7	18	.	11	13
Capsella bursa-pastoris	.	14	9	.	22	13
Species of Artemisietea:						
Convolvulus arvensis	20	7	18	57	.	.
Elymus repens	20	29	9	43	.	13
Melilotus albus	20	.	27	29	.	.
Onopordum acanthium	20	14	9	.	.	.
Carduus acanthoides	20	36	.	14	.	.
Artemisia vulgaris	20	29	.	100	.	25
Cirsium vulgare	20	.	9	.	.	.
Daucus carota	.	14	27	71	.	.
Reseda lutea	.	7	.	43	22	.
Diplotaxis tenuifolia	.	.	18	14	11	.
Others:						
Plantago major	40	43	9	43	.	50
Polygonum aviculare	60	.	73	43	11	50
Lolium perenne	40	.	18	29	22	25
Medicago lupulina	20	14	.	.	11	.
Cirsium arvense	20	14	18	.	.	.

Artemisia annua stands at the foothills of the Monte Baldo (Italy, Prov. Verona)					
Number of the relevé	1	2	3	4	5
Area [m²]	30	60	50	22	20
Vegetation cover [%]	80	85	90	90	98
Number of species	15	18	13	15	20
Artemisia annua	**3.3**	**4.3**	**4.4**	**3.3**	**3.3**
Species of Artemisietea:					
Verbascum phlomoides	1.1	1.1	+	+	1.1
Malva sylvestris	1.1	+	+	2.2	+
Erigeron annuus	2.2	2.2	1.2	1.2	2.2
Artemisia absinthium	1.1	2.1	1.1	.	1.1
Medicago lupulina (D)	+	1.2	.	.	1.2
Melilotus albus	+	.	+	.	.
Convolvulus arvensis	.	+	.	.	+
Silene latifolia ssp. alba	.	.	.	1.2	1.2
Artemisia vulgaris	.	.	.	1.2	.
Others:					
Calamintha nepeta	1.1	2.3	2.3	2.2	1.2
Setaria viridis	2.2	2.2	2.2	2.2	1.2
Conyza canadensis	1.2	2.2	1.2	2.3	2.2
Digitaria sanguinalis	1.1	+.2	1.2	.	.
Hordeum murinum	1.2	.	.	+	+
Chenopodium album	.	+	+	+	.
Trifolium repens	1.2	1.2	.	.	.
Amaranthus retroflexus	.	.	.	+	1.2
….					

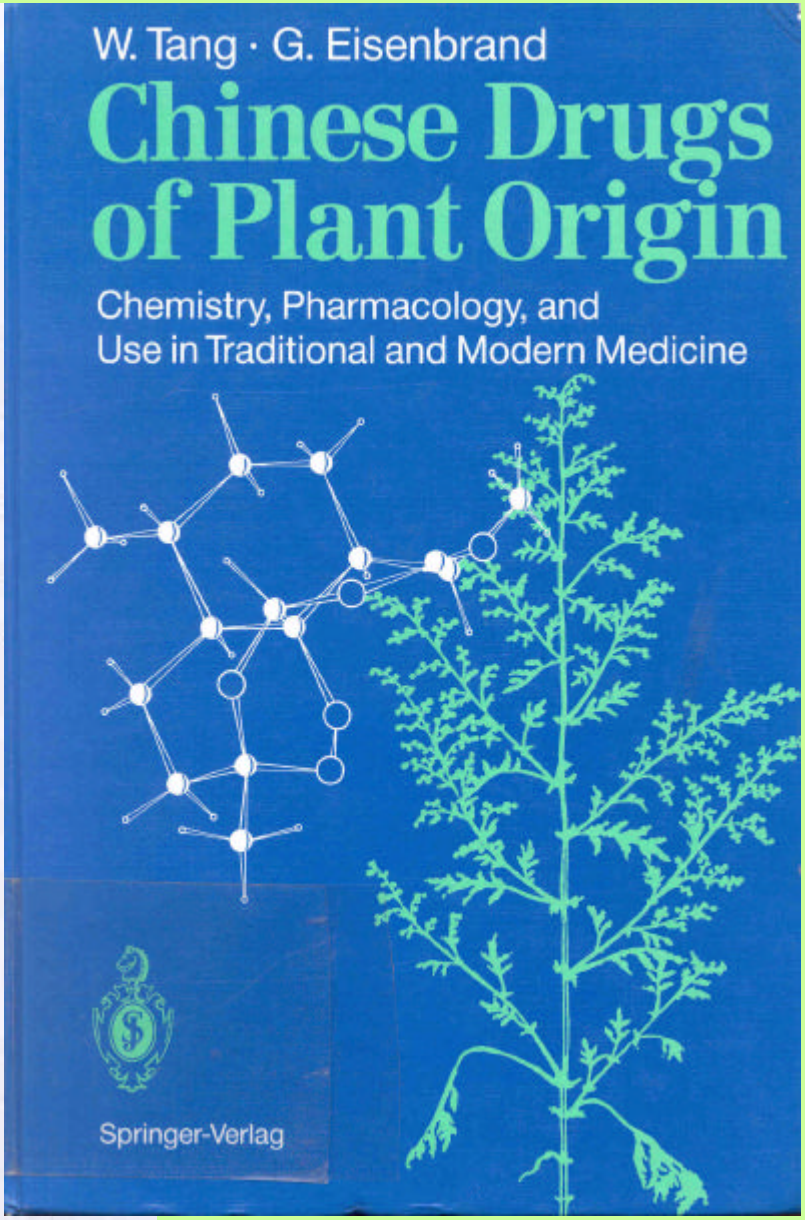
Interactions with biota

- Artemisia annua is a wind-pollinated short-day plant, which may cause severe allergies in autumn.
- The plant suffers only little damage by plant-eaters (herbivores resp. phytophages) or parasites (Cuscuta campestris).

- Artemisia annua is also an old medicinal plant of China. Today it is very interesting as an anti-malaria drug especially for malaria tropica. During the war in Vietnam, Chinese scientists isolated Artemisinin as the active principle and called it Qinghaosu.
- The structure of the endoperoxide is essentiell for the effect against the plasmodia.



Artemisinin
(= Qinghaosu)



Conclusion & Prognosis

- Artemisia annua is able to establish in suburban areas, along traffic lines as well as at the banks of those rivers which in summer have low water. Other possible habitats are fields of root crops.

- Except the distribution by running water A. a. has no effective strategies for long-distance dispersal.

- Soil movements during construction work cause effective short-distance dispersal of the seeds.

- Therefore Artemisia annua has not yet filled the potential areal in Central Europe. The invasion is delayed, at the moment there are some seperated „infection centres“.

- Biological control by plant-eaters respectively by parasites (Cuscuta campestris) has only little significance.

- Nevertheless there is no evidence for displacing any native plant.

- Further need for investigation: We are going to investigate possible allelopathic interactions in additional experiments.